An Approach to Optimize the Fusion Coefficients for Land Cover Information Enhancement with Multisensor Data

Akanksha Garg, Nicolas Brodu, Hussein Yahia, Dharmendra Singh

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[1]Akanksha Garg, [2]Nicolas Brodu, [3]Hussein Yahia, and [4]Dharmendra Singh
[1]akanksha126@gmail.com, [2]nicolas.brodu@inria.fr, [3]hussein.yahia@inria.fr, [4]dharmfec1@gmail.com
[1,4]Indian Institute of Technology Roorkee, Roorkee, India
[2,3]Institut National de Recherche en Informatique et en Automatique (INRIA), Bordeaux, France

Introduction

- ✓ There is a need of such land cover monitoring system which can provide the maximum information of the land cover, generally which is not possible with the help of single spaceborne sensor data.
- ✓ Every single sensor has its own advantages but with some limited information. For ex., PALSAR (Phased Array L-Band Synthetic Aperture RADAR) has good scattering behavior for various land cover but accuracy of agricultural area is not good enough.
- ✓ Application of multisensor data may enhance the accuracy.
- ✓ NDVI (Normalized Difference Vegetation Index) is obtained from optical sensor and scattering behavior obtained from the SAR sensor. With their fusion, it may be possible to enhance the accuracy of agricultural areas.

Objective

Main objective is to fuse the optical (NDVI) and SAR (scattering coefficients of PALSAR) data with optimal weight factors and compute the classification accuracy of agriculture areas using SVM (Support Vector Machine).

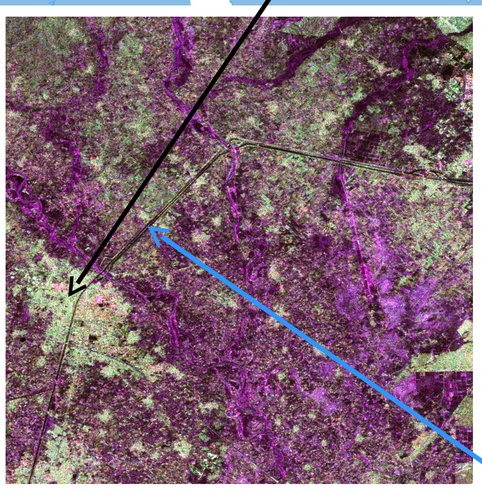
Study Area and Satellite Data Used

Study Area - Roorkee and nearby regions, Uttarakhand, India
Centre Latitude/Longitude of Study Area - 29.89218^0 / 77.95779^0

Dataset 1- PALSAR (Phased Array L-Band Synthetic Aperture RADAR) (12 April, 2011)
Dataset 2- MODIS (Moderate Resolution Imaging Spectroradiometer) (7^{th} - 14^{th} April, 2011)

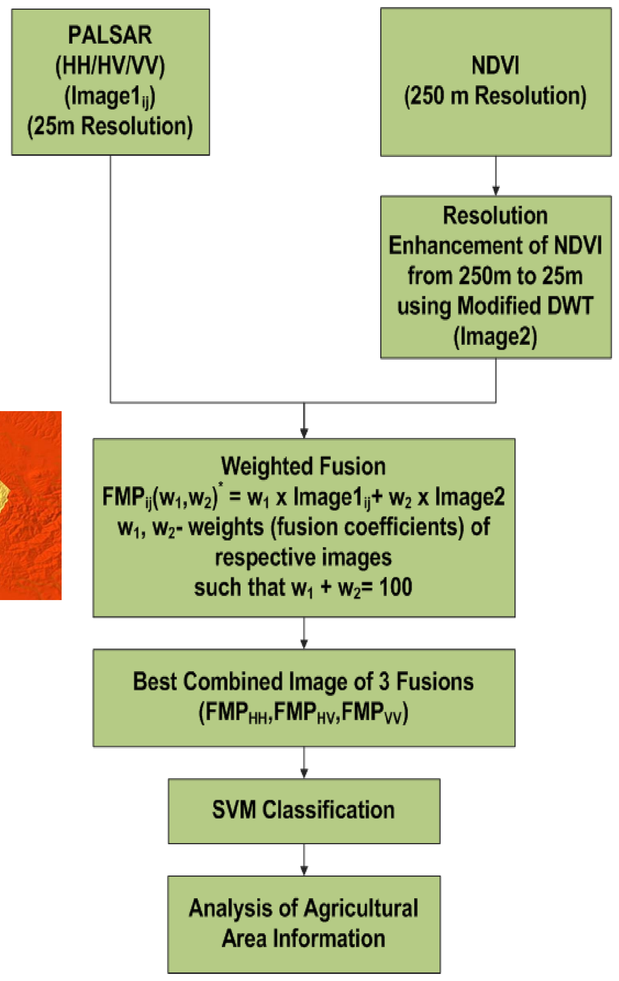
Spaceborne Sensor (Resolution)	Data	Application (Discrimination)
MODIS (250 m)	Band 1 (Red)	Vegetation chlorophyll
	Band 2 (NIR)	Vegetation land cover transformation
	$NDVI = \frac{Band2 - Band1}{Band2 + Band1}$	Vegetation health
PALSAR (25m)	HH Polarization	Double bounce scattering (for Urban)
	HV Polarization	Volume scattering (for Vegetation)
	VV Polarization	Surface scattering (for Bare soil)

Proposed Methodology



FCC (False Color Composite) using PALSAR (HH/HV/VV) of Study Area

Ganga Canal



Flow Chart of the Proposed Methodology

* $\mathbf{FMP_{ij}\ (w_1, w_2)}$ refers to the fused image of MODIS & PALSAR with different polarizations ij at different weights w_1,w_2.
ij - HH/HV/VV polarizations of PALSAR
w_1 – weight of PALSAR(ij)
w_2 – weight of NDVI

Results

Table: Agricultural area accuracy for different fusion combinations

S. No.	Weighted Fusion Combinations $FMP_{HH}(w_1,w_2)$, $FMP_{HV}(w_1,w_2)$, $FMP_{VV}(w_1,w_2)$	Agricultural Region Accuracy (%)
1.	$FMP_{HH}(100,0)$, $FMP_{HV}(100,0)$, $FMP_{VV}(100,0)$ (i.e., without fusing with NDVI)	69.95
2.	NDVI	80.75
3*.	$FMP_{HH}(70,30)$, $FMP_{HV}(80,20)$, $FMP_{VV}(80,20)$	69.48
4.	$FMP_{HH}(70,30)$, $FMP_{HV}(80,20)$, $FMP_{VV}(90,10)$	71.83
5.	$FMP_{HH}(90,10)$, $FMP_{HV}(10,90)$, $FMP_{VV}(90,10)$	77.93
6.	$FMP_{HH}(100,0)$, $FMP_{HV}(10,90)$, $FMP_{VV}(100,0)$	79.34

* For example, S.No. 3 is a weighted fusion combination of 3 fusions – (70% of PALSAR(HH) + 30% of NDVI), (80% of PALSAR(HV) + 20% of NDVI), (80% of PALSAR(VV) + 20% of NDVI)

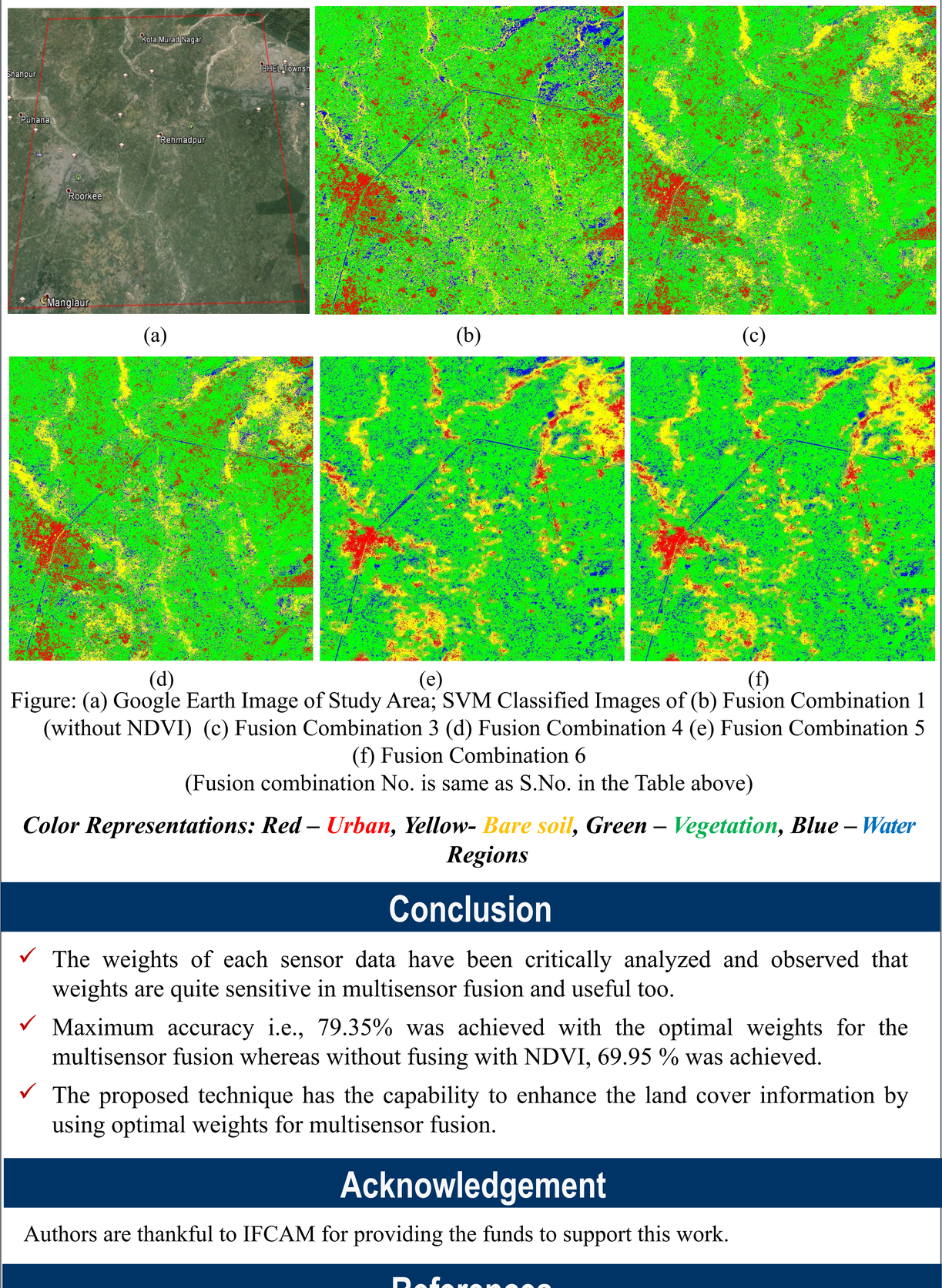


Figure: (a) Google Earth Image of Study Area; SVM Classified Images of (b) Fusion Combination 1 (without NDVI) (c) Fusion Combination 3 (d) Fusion Combination 4 (e) Fusion Combination 5 (f) Fusion Combination 6
(Fusion combination No. is same as S.No. in the Table above)

Color Representations: Red – Urban, Yellow- Bare soil, Green – Vegetation, Blue – Water Regions

Conclusion

- ✓ The weights of each sensor data have been critically analyzed and observed that weights are quite sensitive in multisensor fusion and useful too.
- ✓ Maximum accuracy i.e., 79.35% was achieved with the optimal weights for the multisensor fusion whereas without fusing with NDVI, 69.95 % was achieved.
- ✓ The proposed technique has the capability to enhance the land cover information by using optimal weights for multisensor fusion.

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